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94th Congress
2d Session

COMMITTEE PRINT

RESULTS OF AN OPINION SURVEY ON THE 1977 BUDGET PROPOSAL OF THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

PRINTED AT THE REQUEST OF

HENRY M. JACKSON, *Chairman*

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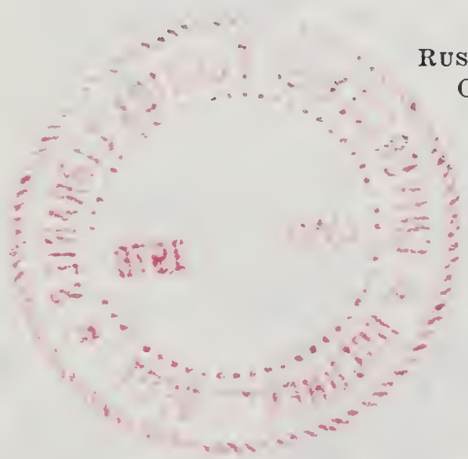

MEMORANDUM OF THE CHAIRMEN

In February and March 1976, the Senate Committee on Interior and Insular Affairs, Subcommittee on Energy Research and Water Resources, conducted hearings on the fiscal year 1977 budget proposed by the Energy Research and Development Administration. In order to help identify areas requiring consideration during the hearings, an opinion survey was sent to a group of non-Government energy experts. These experts are affiliated with industry, academia, and trade organizations, and they have a unique vantage point from which to assess ERDA's 1977 budget proposal because of their participation in a congressionally sponsored evaluation of ERDA's long range plan for energy independence during 1975. Thus, they are in a unique position to assess ERDA's proposed 1977 efforts relative to ERDA's long range goals. Their comments are included in this committee print for the benefit of Members of the Congress and others interested in the progress of ERDA's program. We are grateful for the cooperation of those who responded to the committee's questions. A summary of the results of this opinion survey appears as the first section of this document.

HENRY M. JACKSON,
Chairman, Committee on
Interior and Insular Affairs.
FRANK CHURCH,
Chairman, Subcommittee on
Energy Research and Water Resources.

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RESULTS OF AN OPINION SURVEY ON THE 1977 BUDGET PROPOSAL OF THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

I. Summary of Results of Opinion Survey

A. THE OPINION SUMMARY

The opinion survey letter in its entirety is shown in section III of this report (p. 69). The questions asked are repeated below for convenience:

(1) Based on your participation in the Office of Technology Assessment's analysis of the ERDA long range plan, how would you allocate $1,000 to the various major programs in 1977?

Program

Conservation
Fossil Energy
Solar Energy
Geothermal Energy
Fusion Power Development
Fission Reactor Development
Nuclear Fuel Cycle
Environmental Control Technology

(2) How could you allocate $1.000 to the subprograms in one or more of the program areas with which you are familiar?

(3) Please provide any comments or suggestions you might have regarding the proposed 1977 budget. Of special interest are opinions reached by your panel regarding the long range plans, that are not reflected in next year's budget.

B. RESPONSE TO QUESTIONS (1) AND (2)

Seventeen individuals were surveyed, and of these 12 responded. Nine of the individuals responded to question (1) regarding the breakdown of the direct energy R. & D. budget, and their responses are averaged and presented in table I below. The table also shows ERDA's breakdown and compares the two in the last column. In general the non-nuclear areas would increase and the nuclear areas would decrease if the averaged recommendations of the non-Government energy experts were followed. The results are also presented in pie chart form for the reader's convenience in figures 1 and 2. Most of the respondents used $100 million in their analysis for the amount of money in geothermal R. & D., the remaining $50 million being available for loan guarantees. Therefore, the 3.6 percent recommended for that technology is not considered to be a significant result.

TABLE I.—PERCENTAGE BREAKDOWN OF ERDA'S DIRECT ENERGY R. & D. BUDGET FOR FISCAL YEAR 1977
(BUDGET AUTHORITY)

Program	Amount (millions)	Proposed by ERDA (percent)	Average recommendations by non-Government energy experts (percent)	Comparison of non-Government breakdown to ERDA's breakdown (percent)
Conservation	$120	4.9	6.7	[1] 37
Fossil energy	477	19.6	23.4	[1] 19
Solar energy	160	6.6	7.2	[1] 9
Geothermal	100	4.1	3.6	[2] 12
Fusion power	392	16.1	11.5	[2] 29
Fission reactor	823	33.7	31.2	[2] 7
Nuclear fuel cycle	347	14.3	13.3	[2] 7
Environmental control	16	.7	3.1	[1] 343
Total	2,435	100.0	100.0	

[1] Higher than ERDA.
[2] Lower than ERDA.

TABLE II.—*Recommendations by Non-Government Energy Experts Regarding ERDA's proposed 1977 budgets in the Conservation, Fossil, and Solar Energy Subprograms*

Program, subprograms, and amounts (in millions)	*Recommendation*
Conservation, $120:	
Electric energy systems and storage, $46.8	Decrease ERDA's budget.
Industry conservation, $12.4	Increase ERDA's budget.
Buildings conservation, $21.6	No significant change.
Transportation energy conservation, $23.7	Increase ERDA's budget.
Improved conversion efficiency, $15.5	No significant change.
Fossil energy, $477:	
Liquefaction, $73.9	Decrease ERDA's budget.
High Btu gasification, $45.2	Increase ERDA's budget.
Low Btu gasification, $33	No significant change.
Advanced power systems, $22.5	Increase ERDA's budget.
Direct combustion, $52.4	Do.
Advanced research and support, $37.1	No significant change.
Demonstration plants, $107.2	Decrease ERDA's budget.
Magneto-hydrodynamics, $37.4	Do.
Petroleum and natural gas, $37.2	No significant change.
In situ technology, $31.1	Do.
Solar energy, $160:	
Direct thermal heating and cooling, $45.3	Increase ERDA's budget.
Agricultural process heat, $3	Do.
Solar electric, $102.5	Decrease ERDA's budget.
Technology support, $4	Increase ERDA's budget.
Fuel from Biomass, $4.3	Do.

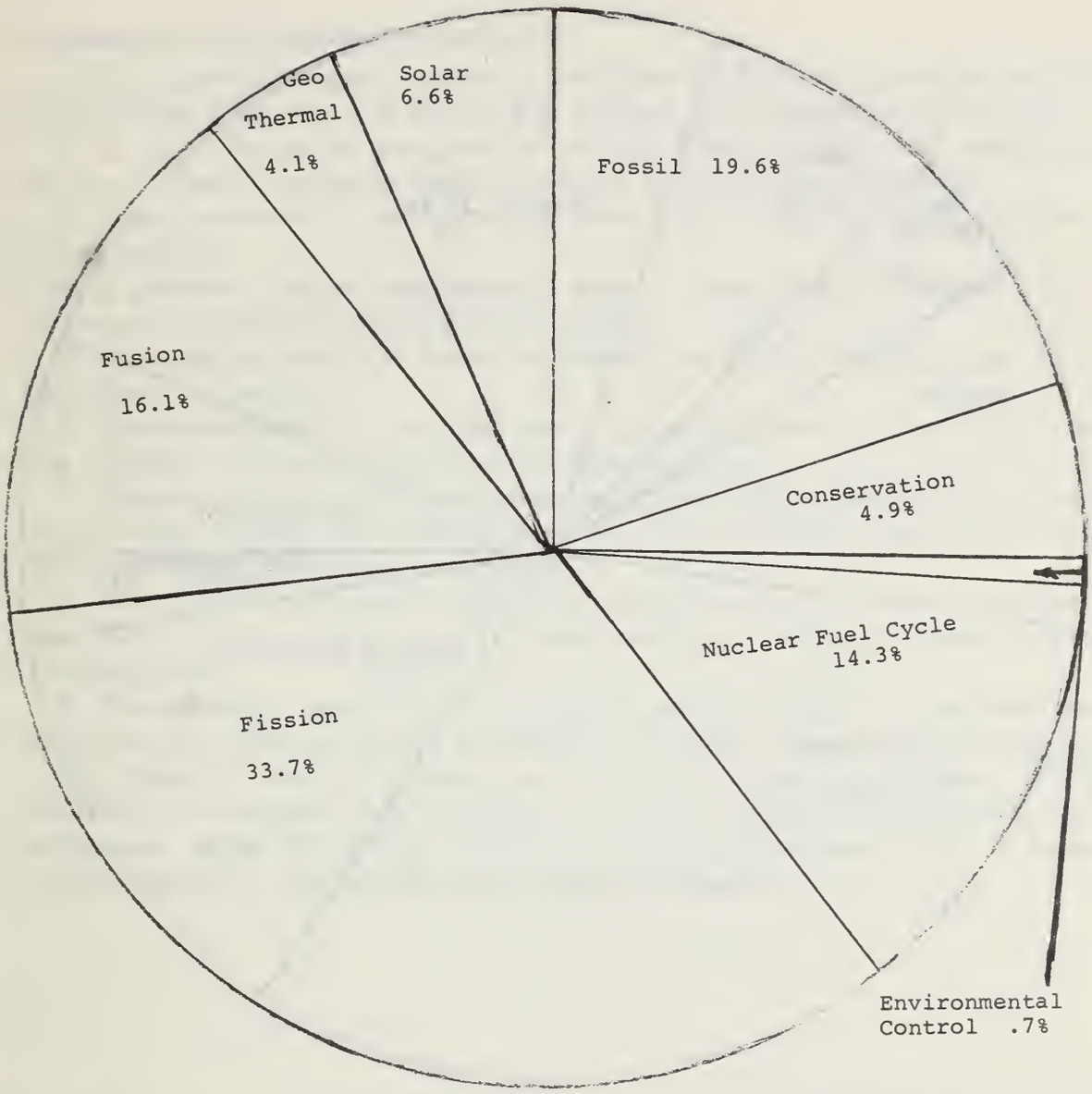

FIGURE 1.—Percentage breakdown for energy R. & D. proposed by ERDA, fiscal year 1977, BA.

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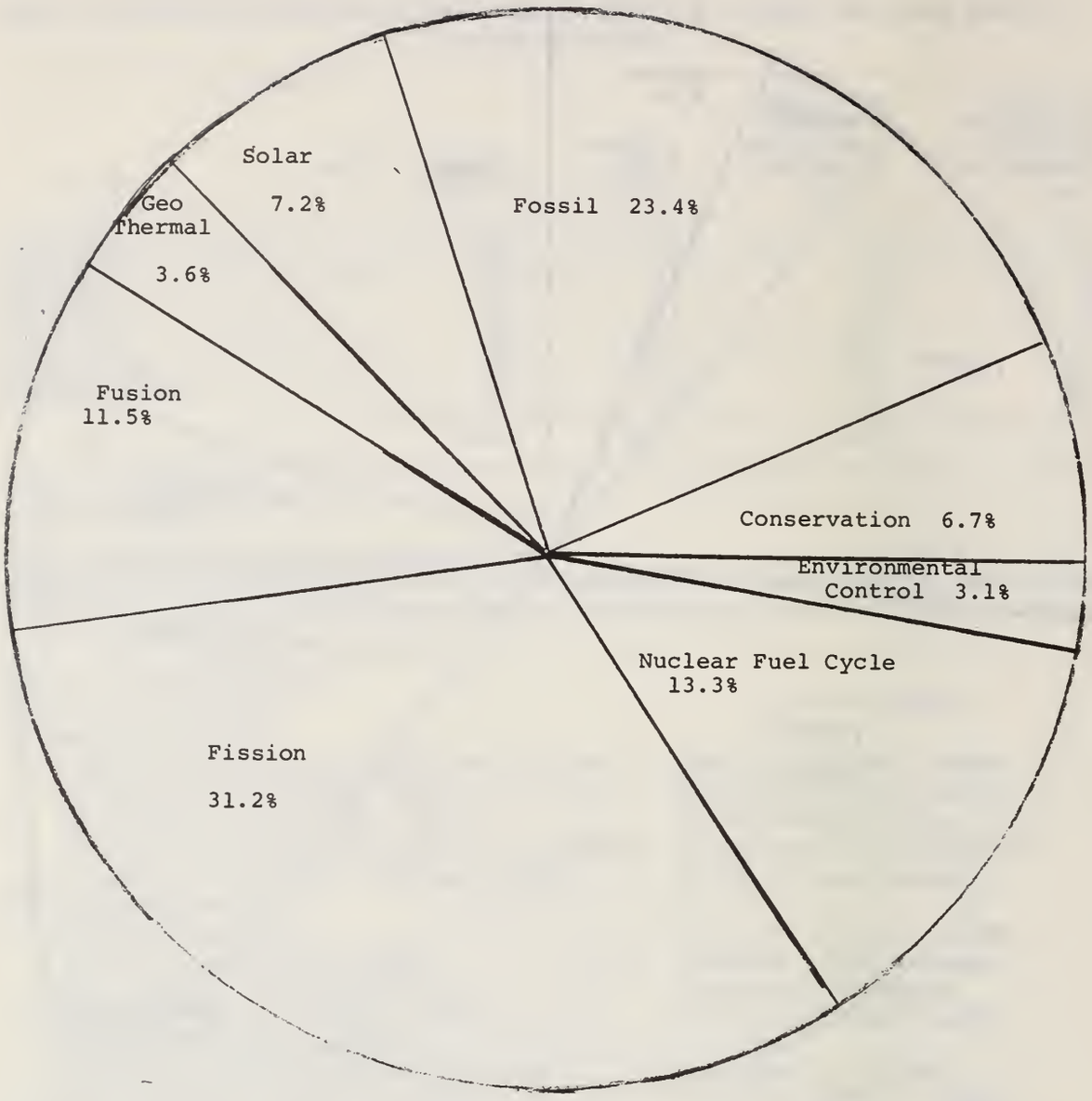

FIGURE 2.—Average percentage breakdown for ERDA energy R. & D. recommended by non-Government energy experts (fiscal year 1977, BA)

For question (2), responses were provided in the areas of conservation, fossil energy, and solar energy. Three to five individuals responded in these areas, and this was felt to be too sparse to present an average comparison with ERDA's budget. However the average was calculated and used to make a qualitative recommendation for increasing or decreasing a particular subprogram. These results are presented in table II. It should be noted that where a given program was increased overall, a decrease in one of its subprograms relative to other subprograms may still represent an increase in the original figures.

C. SUMMARY OF RESPONSES TO QUESTION (3)

There were many comments and suggestions made by the survey group, and some of these are presented here, selecting those that were mentioned by two or more of the respondents. Many of these comments are also reflected in the recommended budget changes of sections A and B.

Summarized Significant Comments

1. The overall energy budget (less than $3 billion) is not adequate, considering that we will spend $28 billion for foreign oil this year.
2. A more balanced program is needed. There is too much emphasis in the nuclear programs relative to the non-nuclear programs.
3. The conservation program is weak both in dollar level and program quality.
4. A greater relative emphasis in shorter term payoff programs (10–15 years) is needed in the ERDA budget.
5. Too much money is being allocated to MHD, which is an over-promised technology.
6. More emphasis is needed on advanced power systems such as gas turbines and bottoming and topping cycles.
7. Present coal liquefaction processes are highly inefficient and uneconomical. Costly demonstrations should be limited and more emphasis given to process development.
8. The solar funding is seriously unbalanced and more emphasis should be given to solar heating and cooling relative to solar electric development.
9. Not enough money is being spent on the highly important environment control problems associated with the various energy options.
10. Electric energy systems and energy storage programs, while excellent in concept and execution, are not normally considered conservation. More generally, electric energy generation lacks a home of its own and is spread through various budgets.

II. Opinion Survey Responses

This section contains the twelve responses to the opinion survey in their entirety. The responses appear in the order listed below:

Professor David Rose, Department of Nuclear Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Dr. Paul P. Craig, Council on Energy and Resources, University of California, Berkeley, California.

Dr. Roland W. Schmitt, Manager, Energy Science and Engineering, Corporate Research and Development, General Electric Company, Schenectady, New York.

Mr. M. S. Sadler, Assistant Director, E. I. du Pont de Nemours & Co., Wilmington, Delaware.

Russell J. Cameron, Cameron Engineers, Denver, Colorado.

Dr. Alvin M. Weinberg, Institute for Energy Analysis, Oak Ridge, Tennessee.

Mr. Eric H. Reichl, President, Conoco Coal Development Company, Stamford, Connecticut.

Professor George O. G. Löf, Solar Energy Applications Laboratory, Colorado State University, Fort Collins, Colorado.

Dr. Jerry Grey, American Institute of Aeronautics and Astronautics, New York City, New York.

Mr. Sheldon H. Butt, President, Solar Energy Industries Association, Olin Brass, East Alton, Illinois.

Mr. R. M. Lundberg, General Staff Engineer, Commonwealth Edison, Chicago Illinois.

Professor S. S. Penner, Director, Energy Center, University of California, San Diego, California.

DEPARTMENT OF NUCLEAR ENGINEERING
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
77 Massachusetts Avenue Cambridge, Massachusetts 02139

Room: 24-210

February 6, 1976

Senator Henry M. Jackson, Chairman
Committee on Interior and Insular Affairs
United States Senate
Washington DC 20510

Dear Senator Jackson:

In reply to your 30 January letter, I am pleased to assist The Senate Interior and Insular Affairs Committee in its task of examining the FY 77 ERDA budget request.

First, here are my answers to your direct questions, with some associated comments. But please note the further discussion of part (3) below.

1. Based on my participation in the OTA assessment analysis of the ERDA long range plan, how would I allocate $1000 among these various major programs?

Conservation	$ 150	(way up)
Fossil Energy	300	
Solar Energy	90	
Geothermal Energy	30	
Fusion Power	80	
Fission Reactor Development	200	
Nuclear Fuel Cycle	100	
Environmental Control Tech.	50	(up substantially)
	$1000	

But please note that I would also include environmental and health consequences as major, main-line items, and allocate $200 to those broad areas besides; this is about double the present ERDA FY 77 fraction. See (2j) below for more details.

2. How would I allocate $1000 to each of various sub-programs?

(a) Conservation

Electric Energy Systems	$ 50	(much smaller, & EPRI should do it)
Energy Storage Systems	200	
Industry Conservation	300	(much more)
Building Conservation	200	

Transportation	100	(get FEA & DOT much more active)
Improved Conversion Efficiency	150	
	$1000	

(b) Fossil

Not capable of judging well on short notice, but (i) cut down MHD, which is highly over-promised, and won't help that much anyway; (ii) increase advanced power systems (gas turbines) even more, if possible, including bottoming cycles as well as topping ones; (iii) ensure that the Federal Government gets its own better data base on resources.

(c) Solar

Direct Thermal Heat & Cool	$ 450	(much more)
Agric. & Process Heat	60	
Solar Electric	440	(less)
Tech. Support & Utilization	30	
Biomass	20	
	$1000	

Note that biomass is less, because if you can grow something to burn, you can grow something to eat, and food will be more critical; but I am in favor of converting biomass waste and other wastes that exist now into fuel, if they cannot reasonably be recycled into the land.

(d) Geothermal

Not expert enough to give a breakdown.

(e) Fusion

Magnetic Confinement	$ 200
Development & Technology	300
Research	200
Reactor Projects	200
Laser Fusion	100
	$1000

Note that the distinction between large "confinement systems" and "reactor projects" is blurred, and the 400 total is more meaningful.

More comments on fusion are:

(i) Do not support the Sandia electron beam fusion to any great extent, because the idea probably won't make a fusion reactor ("Stat. Highlights", p. 20).

(ii) Support 14 Mev high intensity neutron facilities, but not the LASL version without a review; I think better ones may be available ("Stat. Highlights", p. 21).

(iii) Don't support high energy lasers for fusion very much because the concept is probably not viable (p.21).

(f) Fission Power Reactor Development

LMFBR (total)	$ 670	
Water-cooled breeder	40	
Gas-cooled Reactors (total)	110	) Note
Molten Salt breeder	30	) Especially
Light Water Reactor Tech.	50	
Reactor Safety Facilities	50	
Support, etc.	50	
	$1000	

The main difference here is my attempt to broaden the nuclear options, and give more meaningful assistance to our present light water reactor program. In future years, I'd increase the funding for alternatives even more.

(g) Nuclear Fuel Cycle

Uranium Resources	$ 100
Support Nuclear Fuel Cycle	200
Commercial Waste Mgmt.	275
U-235 Process Dev.	200
Adv. Isotope Sep. Tech.	150
Nuclear Materials & Safeguards	75
	$1000

Apparently <u>missing</u>: any appreciable program on Thorium utilization; otherwise, this program looks about right.

(h) Environmental Control Technology

The sum is too small. How do we get the carcinogens and NO_x out of new coal technology products? It won't be easy.

(j) Environmental Research

(i) It should be at least doubled, from the 202 million B/A for FY 77.

(ii) It should include substantial funds for epidemiological and other studies of the effects of fossil fuels.

(iii) It should include at least 50 million for education and training, curriculum development, etc. I argued this in OTA and The House Committee on Science & Technology, and believe this year even more firmly that the energy program will be hobbled by lack of well-trained people.

(iv) Planning and analysis is still strangely placed in this area. What is the relation to Roger Legasse's group in planning and analysis, under Seamans? I am in favor of intelligent planning at all levels, needless to say.

(k) Basic Research

Material Sciences should be increased, mainly in the non-nuclear related areas.

3. Other Comments.

(a) This budget is appreciably improved over the FY 76 originally submitted version, and ERDA should be congratulated for stronger programs in conservation (especially, end-use), nuclear waste management, and nuclear fuel cycles, for example.

(b) Still, is the budget adequate for the task (a question asked by OTA)? We expect to pay about $28 billion for foreign oil this year, and here we have a direct energy RD&D Program proposed for less than $3 billion. The benefit/cost ratio for a more vigorous program would be large. New energy will be expensive.

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(c) ERDA is too timid, another point made by strong inference last year by OTA. Where are studies of international effects, socio-economic effects, energy options for cities, education and training, public information (I don't mean advertising or articles in scholarly journals, although the latter is laudable), arrangements for coordination with other government and non-government groups, commercialization, attention to constraints, etc?

Some of these activities are listed in the "Program Support" section, yet I fear that they will be inadequate, if past history is a guide.

We need an ERDA that steps out to cover every bit of unoccupied important intellectual area related to energy, and persists in doing so until either the ground is covered or some higher authority says "Stop"; if the latter, we can then debate the situation from there.

(d) Conservation is still too gingerly approached. The benefits are immense, and we will need to conserve all we can.

(e) I enclose a 60-page essay on our present energy problem, written from a long-range point of view; it is the introductory summary of my MIT course on Energy this year. Your staff may find it useful.

This concludes my response to your letter. Please call or write if you wish more information.

Yours sincerely,

David J. Rose
Professor

DJR/p
Enclosure

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Council on Energy and Resources

BERKELEY, CALIFORNIA 94720

February 9, 1976

The Honorable Henry M. Jackson
United States Senate
Committee on Interior and Insular Affairs
Washington, D.C. 20510

Dear Senator Jackson:

I am very pleased to respond to your request to comment upon the ERDA budget submission to the Congress for FY 1977. This is the first budget developed entirely by ERDA, and consequently is of particular significance as a statement of ERDA objectives and priorities.

General Comments

The major challenge facing ERDA during its first year was to overcome the image of the Atomic Energy Commission of an agency promoting a particular technology--nuclear energy--and to develop a balanced national program which would open many options to the nation. Such a balanced program would lead to a multiplicity of national choices for the evolution of our energy system. And such a program would provide comprehensive information on the disbenefits as well as the benefits of each option--the environmental, social, public health and safety information which is essential if wise national choices are to be made.

An excellent framework for such a balanced program was in fact laid out by ERDA itself in its plan for Energy Research Development and Demonstration (ERDA-48) submitted to the Congress on June 30, 1975.

Unfortunately, the ERDA budget for FY 1977 does not make major progress in achieving such a balanced program.

The emphasis upon nuclear energy which was characteristic of AEC is retained in ERDA. Solar energy and energy conservation, two areas identified by ERDA in its planning documents as being of importance comparable to nuclear energy, remain very small relative to nuclear. The following numbers illustrate this emphasis:

- Nuclear fission and fusion projects, which were 52% of the ERDA budget in FY 76, are 50% in the FY 77 budget. There is no significant change in program balance.

- The total budget for solar energy ($116 million) is less than half (46%) of the increase alone in the fission and fusion programs ($267 million).

- The total budget for energy conservation ($91 million) is just one-third of the increase alone in the fission and fusion program ($267 million).

In considering these numbers it must be observed that a low relative budget in an area does not in itself demonstrate inadequate support. The potentiality for payoff of the area, the proposed program plan, and the need for federal involvement are factors which must also be taken into account. In my opinion, the opportunities present in both solar energy and energy conservation warrant federal involvement at levels above those of the ERDA budget document. The following pages offer commentary on several specific ERDA programmatic areas.

SOLAR ENERGY

ERDA appears to have made a decision to emphasize electrical applications as the dominant long term application for solar energy. This is consistent with a general emphasis within ERDA on high technology approaches to energy supply, and de-emphasis on lower technology approaches (e.g., industrial process heat) which might well turn out to be technically simpler, cheaper, and more reliable.

- The Solar energy program has made a programmatic decision to emphasize predominantly electricity production, and building heating and cooling. Bioconversion, which has major potentialities, is actually downgraded in the FY 77 budget (from $3.830 million (FY 76) to $3.0 million (FY 77).

- Agriculture and process heat activities are also downgraded (from $3.7 million (FY 76) to $2.5 million FY 77).

- The Solar Energy Research Institute - mandated by Congress but not yet acted upon in any way by ERDA - is budgeted for $1.6 million in FY 76 but only $1.0 million in FY 77.

  This suggests that ERDA does not intend that SERI rapidly become a highly visible center of solar research activity. In my opinion, such a center is a necessity if solar is to achieve the prominence it deserves, and if a strong national solar research community is to be developed.

The imbalance of the ERDA solar program may also be illuminated by comparing the budgetary priorities with the potential impact of solar energy as estimated in the Project Independence report. The comparison is shown in the following table, which suggests that bioconversion is being underfunded relative to other approaches. The photovoltaic budget is adequate, but the emphasis on mass production in contrast to improving scientific knowledge may not lead to the strongest program.

	% OF SOLAR		
	Project Independence		ERDA FY 77
	Accelerated 1990	Implementation 2000	Solar Budget
Heating and Cooling	30%	9%	31 %
Solar Thermal	0.4%	3.4%	24 %
Wind Conversion	41%	13%	11%
Bioconversion	18%	29%	2.7%
Ocean Thermal	4%	18%	6.3%
Photovoltaic	6%	18%	20%
Other (Technology Support, SERI, etc.	--	--	5%
Total impact - quadrillion BTU	4.92	38.8	
% of projected U.S. demand	3%	22%	

*Totals do not add to 100% due to rounding.

The solar program document provides no suggestion as to how priorities are developed. The above table suggests (and review of the solar program confirms) that increased attention to methods for determining budgetary priorities is needed in the solar program if the promise of solar energy is to be realized.

BASIC RESEARCH

ERDA has primary federal responsibility for the maintenance of the soundness of fundamental science in the energy area. (The National Science Foundation, which formerly played a major role in this area, now has virtually no energy program.) The 9% increase in the basic science program from $187.9 million (FY 76) to $204.4 million (FY 77) is barely enough to offset inflation.

The long term solution of energy problems will require increased knowledge in many areas. Examples are materials research and combustion research. Knowledge developed in these and other areas can be expected to contribute to the strength of the more technical programs, and the presence of persons carrying out basic research constitutes a resource which can be drawn upon by the applied ERDA programs. The basic science activities in ERDA are not well coordinated with the needs of the developmental programs.

ENVIRONMENTAL RESEARCH

This program was held to an increase of 8%, approximately constant in fixed dollars, yet the environmental research program is critically important to the

ERDA mission, for early identification of environmental problems associated with emerging energy systems offers the only hope for timely preventive action. These programs should be closely coordinated with energy supply technology programs, and especially in the development of environmental impact statements (including generic statements) on these programs. The AEC developed over many years a strong capability for understanding the effects of radiation. Similar programs are required for fossil fuels. An encouraging sign is increased emphasis in the environmental research program on expanding the systems analytic capability within ERDA. This program (Analysis and Assessment) can provide ERDA with advance warning of potential problems with implementation of new technologies, and could prove critical if ERDA is to avoid the problems with public acceptability which proved so damaging to the AEC.

CONSERVATION

The task of energy conservation is to escape from historic patterns of exponential growth in energy demand with minimal adverse societal impact. Energy demand is highly differentiated in both its causes and its patterns. While supply technologies tend to be few in number and expensive, energy conservation approaches are diverse and extensive. Thus, the design of a coherent, effective energy conservation program may be expected to prove far more complex than the design of most energy supply programs. A well thought-out program plan is a necessity to justify the substantial budget which energy conservation warrants - but does not have.

Unfortunately, conservation is the weakest portion of the ERDA budget, both in dollar level and in program quality. The total proposed budget is $91 million - only 3.8% of the ERDA energy budget. This results in funding levels which are far too modest across the board in the conservation program. The situation is compounded by seriously deficient program design, which does not convincingly justify increased emphasis in conservation. The challenge to the conservation program is to bring in persons capable of developing a good plan, to fully justify each element, and to build up a major program. The ideas exist, but have not effectively penetrated ERDA.

Within the conservation budget are large elements not in areas generally considered to be energy conservation. The program element labelled "Electric Energy Systems and Energy Storage" is budgeted at $37.9 million - a full 39% of the total conservation budget. This program element is dominated by research on technologies such as superconducting transmission drives and advanced batteries. These projects are generally excellent in concept and execution and are important for ERDA to carry out. But to label them conservation programs is misleading. The rationale for improved underground transmission, for example, is (properly) based entirely on environmental and right-of-way considerations.

While the electric technology programs are long range in character, most of the rest of the conservation program has a remarkably short-range orientation. The dominant objectives seem to be:

- Short term pay-off in energy savings.
- Fast pay-off in dollars.

Because energy conservation is such a new area there do exist many opportunities for improvement characterized by very rapid pay-off periods. Programs targeted for short term pay-off are clearly critical to rapid implementation of energy-conserving technologies and programs. ERDA should, however, also take a longer view, including within its program projects with long term objectives as well, for here there is considerably less incentive for private sector investment.

New energy supply technologies are capital intensive and carry high risk. To be commercially acceptable these systems must operate for decades. Amortization time for a power plant is typically thirty years. Energy conservation programs should provide a balance which includes elements with long as well as short economic pay-off times. It is the long term projects which are likely to prove of most importance for changing the energy intensity of our society, just as ERDA's energy supply projects are primarily oriented toward meeting the critical long term needs of the nation.

It will be particularly necessary to emphasize those projects which are not readily carried out by the private sector. These are not necessarily extremely large projects (although they may require expensive demonstrations) but may have a highly diversified and fragmented domain of implementation.

The overall conservation budget shows little evidence of an aggressive stance. Some examples of the timidity of the program are:

- A section called "Dissemination and Transfer" (page CR/U-45) calls for the establishment of Energy Action Centers in each state. A convincing rationale for such centers is given. However, for such centers to be effective at large scale communication each one would need to operate at an annual level approaching $1 million. Yet the total project budget is just $500,000.

- Urban design offers an extremely attractive area for a major, long range program which could fundamentally affect our use of energy. The energy implications of urban design are touched upon in the Community Systems program, budgeted at $5.7 million. This budget is barely enough for one demonstration - and to achieve broad impact there would have to be many demonstrations throughout the nation (a point clearly appreciated in the solar heating and cooling plan, which recognizes the need for geographical dispersion).

- In the industrial sector experience to date shows the potential for considerable increases in the efficiency of energy use. Designs of energy conserving equipment and processes can cost hundreds of thousands of dollars each and must be numerous as there are many industrial processes. Further, some projects such as an energy optimized industrial park study (page CR/U-14) could cost very much more, if the task were well executed, while offering the potential for major energy savings. Yet, the total industrial sector budget is $9.26 million. Federal investment in industrial energy conservation merits a large share of the total ERDA budget slated to go to industry for the development and commercialization of new energy technologies. Conservation has at least as great a likelihood of pay-off as do investments in supply options.

Finally, it must be noted that the Conservation program has been characterized by extreme organizational instability and confusion. With a few exceptions the program has projected an image of lack of sharp focus, and of rapidly changing objectives. This has made the program very difficult for those outside of ERDA to deal with. A major shortcoming within the program is the virtual absence of an analytic element with responsibility for laying out and analyzing energy conservation options. Such a program element is relatively inexpensive, but serves as the all-important compass to provide the information necessary for determining direction.

SYNFUEL COMMERCIALIZATION

The synthetic fuels commercialization program included in the ERDA budget has a negligible budget. The strong Administration support for this program and its potential large size assures that this program will be the subject of much discussion and debate during FY 77. This program could have the effect of heavily subsidizing a set of unproven supply technologies with high environmental costs. If such a program is to be established, the possibility should be considered of expanding it to include energy use technologies. A major commercialization (or subsidization) program in energy conservation could well have more impact on the U.S. energy system than a corresponding supply program.

ERDA FUNDING PRACTICES

ERDA is rapidly developing a funding procedure which relies extensively upon "Requests For Proposals." This procedure, which is excellent for well defined projects, is less suitable in diverse or poorly structured areas, or in areas where new fundamental knowledge must be developed. Too heavy reliance on RFP's can deter the support of innovative ideas. Many of ERDA's responsibilities lie in areas where innovation may be critical (solar and conservation are examples). Rather than constraining its programs ERDA should expand its capability to respond to innovative unsolicited proposals in areas outside of established programs or cutting across ERDA's programmatic categories.

This situation is especially serious for the University research community. Unless special precautions are taken the resources of the universities may not be effectively utilized by ERDA. While ERDA has taken limited actions to address this problem, it is my observation that the situation is deteriorating, and requires more attention from ERDA management.

It has been a pleasure for me to have this opportunity to comment upon the ERDA FY 77 budget. I will be pleased to expand upon any of the points raised.

Yours sincerely,

Paul P. Craig

cc: E. Daddario, Director
Office of Technology Assessment

GENERAL ELECTRIC

CORPORATE RESEARCH AND DEVELOPMENT

GENERAL ELECTRIC COMPANY, RESEARCH AND DEVELOPMENT CENTER, P.O. BOX 8
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Building K-1, Room 3A18
February 27, 1976

Senator Henry M. Jackson
Chairman--Committee on Interior
and Insular Affairs
United States Senate
Washington, D.C. 20510

Dear Senator Jackson:

In response to your letter of January 30 regarding ERDA's proposed F.Y. 1977 budget, I have shown below ERDA's proposed proportionate allocations of $1000 among various programs compared to my own allocations. A few comments are also added in each case. These are my personal views and do not necessarily reflect those of General Electric.

These proportionate allocations are not independent of ERDA's total budget; for example, should ERDA's budget be increased or decreased substantially the recommended ratios would change. The ratios given below assume a total budget comparable to that proposed by ERDA for F.Y. 1977. Also, it assumes comparable management and technical skills in administering each part of the budget, and substantial involvement of industry in each part of the budget.

In arriving at the conclusions below, I have applied the following criteria for evaluating the programs:

1. Energy impact: measure of percentage of U.S. consumption saved, produced, or converted.

2. Necessity for R&D: is the solution of the problem completely dependent on new technology or is it basically non-technical?

3. Necessity for government involvement: is development proceeding at a satisfactory rate in private industry or is progress dependent on government involvement?

4. Technical barriers: can the barriers be solved by demonstrating already developed technology or are there formidable technical barriers?

5. Alternative solutions: are there easily developed alternative solutions or is the approach unique?

6. Implementation probability: if the R&D is successful, will it be easily implemented or are there large socio-economic barriers yet remaining?

7. Time frame of implementation: when will a product be expected on the market - 1976-1985; 1985-1995, after 1995; after 2025?

These criteria are quite similar to ones we have been using in establishing priorities for our own energy R&D programs. I believe they provide the kind of disciplined approach needed to assure adequate support for programs most likely to help solve our energy problems. They will also help screen out those programs which do not promise significant energy contributions, however interesting they may be from a purely technical and scientific viewpoint.

In the allocations that follow, I have restricted consideration to only the Direct Energy Programs of the RD&D portion of ERDA's budget; moreover, the item of $50M in budget authority for the Geothermal Loan Guarantee Program has been omitted. Initially, $1000 is allocated among the eight major Direct Energy Programs; then the amounts allocated to each of these are further allocated to sub-programs. The principal differences between ERDA's allocations and those given below stem from the relative emphasis on short term vs. long term programs. I believe that there should be greater relative emphasis on short term programs with good prospective payoff until such time as we have assured our energy supply for the next 10-15 years. As such assurance comes into view, a gradual shift of emphasis toward the more permanent but longer term energy options would then be appropriate.

GENERAL ELECTRIC

1. Allocation of $1000 among major programs

	ERDA 1977 B/A	
Conservation	50	80
Fossil Energy	200	270
Solar Energy	67	50
Geothermal Energy	21	20
Fusion Power	164	80
Fission Reactor Development	345	300
Nuclear Fuel Cycle	146	140
Environmental Control	7	60
	1000	1000

Comments:

a) ERDA is not putting enough emphasis on Conservation and Fossil Energy; proportionately too much on Solar and Fusion.

b) The recommendation for ERDA to increase relative emphasis on Environmental Control Technology represents my view that ERDA has a more balanced view of the Nation's energy problem than EPA has, and, therefore, is likely to weigh the need for specific Control Technology differently from EPA; if so, ERDA should act accordingly.

2. Allocation among fossil sources

	ERDA 1977 B/A	
Coal		
Liquefaction	31	30
High Btu Gasification	19	25
Low Btu Gasification	14	30
Advanced Power Systems	9	40
Direct Combustion	22	30
Advanced Research & Support	15	14
Demonstration Plants	45	59
MHD	16	12
Petroleum and Natural Gas	16	20
In-situ Processes	13	10
	200	270

Comments:

a) Main disagreement with ERDA is that they are spending proportionately too much on MHD; too little on Gasification generally, especially Low Btu Gasification, on Advanced Power Systems, and on Demonstration Plants.

b) The budget still indicates no line item for integrated low Btu gas-combined cycle systems even though this was among the recommendations of the OTA study of the ERDA budget.

c) In fact, electric power generation as such continues to lack a home of its own; it is spread through the various divisions.

3. Allocation among solar

	ERDA 1977 B/A	
Heating and Cooling	19	23
Agricultural and Process Heat	2	2
Solar Electric	42	21
Technology Support & Utilization	2	2
Fuels from Biomass	2	2
	67	50

Comments:

a) ERDA's emphasis on solar electric is much too high; in fact, in my opinion, the work on ocean thermal is unwarranted beyond a minimal exploratory research effort.

b) Major shift should be toward industrial and residential/commercial use of solar heat.

4. Allocation among geothermal

	ERDA 1977 B/A	
Engineering R&D	5	7
Hydrothermal Technology	5	3
Advanced Technology	5	4
Environmental Control	2	2
Resource Exploration	4	4
	21	20

Comments:

a) Have omitted consideration of loan guarantee in the ERDA allocation.

b) Main difference is that ERDA should put more into Engineering R&D, e.g., heat exchangers, low temperature cycles, somewhat less into hydrothermal technology.

5. Allocation among nuclear technologies

	ERDA 1977 B/A	
Fusion		
Magnetic	122	59
Laser	42	21
	164	80

Comment: No serious disagreement in relative emphasis.

Fission Power Reactor		
LMFBR	275	230
LWR Technology	5	20
Reactor Safety Facilities	14	20
All Other	51	30
	345	300

Comments:

a) Highest priority should be on improving availability of LWR's and on developing the LMFBR.

b) All Other technologies do not look as needed or attractive in the medium term.

	ERDA 1977 B/A	
Nuclear Fuel Cycle		
Uranium Resource Assessment	15	21
Uranium Enrichment Technology	59	42
Nuclear Fuel Cycle	26	21
Waste Management	34	42
Safeguards	12	14
	146	140

Comments: Would give somewhat more emphasis to resource assessment and waste management, slightly less to enrichment.

6. Allocation among conservation

	ERDA 1977 B/A	
Electric Energy Systems and Storage	20	25
End-Use Conservation		
Industry	5	15
Buildings	9	7
Transportation	10	16
Conversion Efficiency	6	17
	50	80

Comments: Would give slightly more emphasis to industry, transportation, and conversion efficiency.

I appreciate the opportunity to submit these views for your consideration; I would be happy to offer further comments or explanations should you wish to have them.

Sincerely,

Roland W. Schmitt
Research & Development Manager
Energy Science & Engineering

RWS:emk

FORM L9-4676-B

DU PONT
REG U S PAT OFF
ESTABLISHED 1802

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
WILMINGTON, DELAWARE 19898

February 17, 1976

The Honorable Henry M. Jackson
Chairman, Committee on Interior & Insular Affairs
United States Senate
Washington, D. C. 20510

Dear Senator Jackson:

ERDA's Fiscal Year 1977 Budget

Thank you for your letter of January 30, 1976 to Donald W. Hallman asking for Du Pont's views on ERDA's FY 1977 budget. Although your letter has been referred to me for reply, the views expressed below represent the collective thoughts of a number of people within Du Pont who have expertise and responsibility in areas covered by the ERDA 1977 budget.

Of all the nation's resources, in our view only coal and nuclear power have the potential to lessen substantially this country's future dependence on imported oil. ERDA programs should, therefore, accord the highest priorities to research and development of these two critically important resources. Conservation programs with potential for achieving significant near-term energy savings should also have high priority and such programs should emphasize especially the maximum application and exploitation of existing technology.

Solar, geothermal, and other advanced energy systems are either very long range or else are unlikely to contribute in a major way toward solving this nation's energy needs. Consequently, these programs should be given lower priority consistent with their stage of development and expected long-range impact.

ERDA programs appear to be in general accord with these guidelines. However, in our judgement, the emphasis in certain areas should be modified. While we are unable to apportion specific dollar amounts to each of the program and sub-program areas, we have

indicated in Appendix A the way we would suggest apportioning the total ERDA budget among major program elements.

Finally, Appendix B contains background information in support of our views on programs concerned with coal, nuclear energy, and conservation.

Sincerely yours,

M. S. Sadler

M. S. Sadler
Assistant Director

MSS:mk
Attachments

APPENDIX A

Opinion Survey Response

Major Program Areas

Program	Recommended Allocation Percent of ERDA FY-1977 Outlay
Conservation	5
Fossil Energy - Coal	27.5
- Other	2.5
Solar Energy	4
Geothermal Energy	0.5
Fusion Power Development	10
Fission Reactor Development	35
Nuclear Fuel Cycle	15
Environmental Control Technology	0.5
	100.0

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Opinion Survey Response

Sub-Programs

	Recommended Allocation Percent of FY 1977 in Sub-Program
Conservation	
Electric Energy Systems	10
Electric Storage Systems	10
Industry Conservation	11
Buildings Conservation	24
Transportation Conservation	40
Improved Conversion Efficiency	5
	100
Fossil Energy - Coal	
Liquefaction	10
Gasification - High Btu	25
- Low Btu	3
Advanced Power Systems	5
Direct Combustion	32
Advanced Research & Supporting Technology	16
Demonstration Plants	5
Magnetohydrodynamics	3
Other Capital Equipment	1
	100
Solar Energy	
Direct Thermal - Heating & Cooling	60
- Agricultural & Process Heat	5
Solar Electric Applications	5
Technology Support & Utilization	10
Fuel from Biomass	20
	100

APPENDIX B

Du Pont recommends that Federal support of energy research and development concentrate on coal, nuclear energy, and conservation of energy. Specific recommendations are based upon the assumptions that key elements of a national energy policy would be designed to:

- Reduce substantially the country's dependence upon imported oil and thus minimize the danger to the domestic economy of a sudden interruption in the flow of imported oil.

- Develop alternatives to oil and gas as the major sources of fuel and feedstock supply.

- Develop abundant new sources of energy that can sustain the traditional growth pattern of the U.S. economy for decades and comply with requirements for maintaining acceptable environmental quality.

COAL

The use of coal will have to be greatly increased between now and 2000 to meet the country's needs both for energy and chemicals. Coal is in greater reserve than any other fossil deposit in the United States and more technology and knowledge exist for winning and processing this basic raw material than for any other of the possible substitutes for petroleum.

ERDA should continue support of programs on coal which are categorized as near, mid, and long term to denote the expected timing for achievement of results that should have significant impact on the nation's use of energy.

Near-Term (1975 to 1985) Coal Programs

Gasification of Coal

Conversion to High Btu Gas - Since the shortage of natural gas is the most severe energy problem confronting this nation near term, projects for conversion of coal to high Btu pipeline gas (SNG) should receive high priority in the next decade. Although technology in this area has advanced to the stage where large commercial size

plants are now being built, present processes are relatively inefficient and are a long way from being economically competitive and acceptably efficient from an energy basis. For example, the first high Btu gas plants to come on stream will be designed to produce 250 MM cu. ft. of SNG per day and will consume about 20 M tons of coal per day. Coal produced in the U. S. now supplies about 20% of the country's energy needs. If all of this coal were to be converted to SNG by present processes, the gas produced would supply only about 10% of the nation's requirements.

Clearly, if SNG is to become an important commercial product in the future, processes for its manufacture must be greatly improved. Therefore, greater emphasis and strong support should be given to second generation, more sophisticated SNG processes now under development that are principally based on high temperature, high pressure, fluidized bed, and multiple reactor technologies.

Conversion to Low Btu Gas - Although a variety of processes for production of low Btu gas are under development, most are modifications of a process that has long been exploited in the manufacture of town gas. The principal target of current programs is conversion of coal to low Btu gas that is free of particulate matter and sulfur and that accordingly is an environmentally acceptable fuel for generation of electric power. Successful development of such processes should provide an attractive alternative to complete combustion of coal which is plagued with the problems of removing sulfur and fly ash from stack gas.

Support for worthwhile projects on processes for low Btu gas should continue and should be augmented with support for engineering work to demonstrate the practical use of low Btu gas in combined cycle processes for generating electric power. In such processes, the hot gas would be fed first to a gas-fired turbine and then to a conventional steam turbine generator to produce steam. The over-all system efficiency is expected to be in the neighborhood of 50 - 60% which compares with the average of 35% for conventional steam plants.

Mining and Transportation - In spite of annual capital expenditures of more than $500 million since 1970, the coal industry has little spare production capacity today. The National Coal Association forecasts that production of coal will have to increase by about 40% to satisfy projected demands in 1985 for conventional uses alone and that many billions of new capital must be raised to achieve this goal. To give some perspective of the impact that coal gasification would have, about 75 plants of the size now planned would consume all of the coal currently produced in the U. S. and the output of these plants would amount to only slightly more than one-third of the natural gas produced in the United States.

While strip mining is attractive, it is beset by environmental problems and today only about 45% is produced this way. Furthermore, facilities for transportation of increased volumes of coal do not exist and presently installed facilities are deteriorating rapidly. Therefore, even in the absence of new demands for coal for conversion to fuel and chemicals, the industry faces monumental problems in expanding production. While these can undoubtedly be solved, it will require extraordinary measures and concerted action by Government and industry. This is a problem that clearly cannot be helped significantly with R&D dollars but can, with strong leadership and a consistent policy.

Mid-Term Programs (1985 to 2000)

Liquefaction of Coal

Most processes now under development were sponsored in recent years by the Department of Interior through the Office of Coal Research and Bureau of Mines in partnership with energy companies and trade associations. Although fuels are the principal product in all cases, the output under optimum conditions may contain as much as 20% petrochemicals that are economically recoverable. Liquids are produced from coal by one of three general processes - pyrolysis, non-catalytic hydrogenation, and catalytic hydrogenation.

As yet no one process has emerged as superior to the others and support for all should be continued with the target of selecting one or two of the most promising for scale-up by 1985. While all programs in this area are concerned primarily with production of liquid fuels, a secondary objective in some cases is a clean-burning solid fuel. These are clearly appropriate goals but Du Pont believes that such programs should also include evaluation of processes for producing petrochemicals of value to the chemical industry.

The need for development of an alternative to petroleum for supply of liquid fuels and chemical feedstocks is of major economic importance to the country and its chemical industry. The present coal liquefaction processes are highly inefficient and uneconomical and the emphasis for some years to come should be on further development and improvement of these processes and not, as some have proposed, on early construction of a number of demonstration plants which would require a large, wasteful investment.

NUCLEAR ENERGY

Near Term (1975 to 1985)

The lag time between issuance of a construction permit and completion of a nuclear power plant is 8 to 10 years. For this reason, it is most appropriate during the next decade to emphasize further development and use of the light water reactor (LWR) and to a lesser extent the high-temperature, gas-cooled reactor (HTGR).

There are two major problem areas impeding expanded use of these reactors to serve the country's energy needs. These are concerned with the need for satisfactory commercial demonstrations of:

- Environmentally acceptable methods for disposing of fission products and plutonium residues remaining after fuel reprocessing.

- Plutonium recycle from spent fuel elements.

Technology for separation of uranium and plutonium from spent fuels and isolation of waste fission products has been practiced in Government-owned plants for over 30 years yet there is presently no commercial facility in operation. The first such facility is scheduled to go on stream by mid-1976 but environmental and regulatory pressures threaten to postpone operation until 1978 or even later. A concerted effort is needed now to overcome these objections and to establish a viable commercial operation. ERDA's budget indicates that not as much urgency and importance is being attached to accomplishment of this task as we in Du Pont believe is warranted.

The same comment applies to commercial demonstration of recycle of spent fuel element plutonium into fresh fuel. Such a process will reduce fresh uranium requirements by about 30% and uranium enrichment investment by about 20%. No technical innovations are required but there remains the task of demonstrating to nuclear opponents that a commercial facility can operate with acceptable environmental impact and with adequate safeguards against diversion of plutonium by terrorist groups. This, too, could prove to be a critical stumbling block and prompt and aggressive support by ERDA and others is needed to accomplish the needed demonstration as soon as possible.

Mid-Term (1985 to 2000)

According to present estimates, the country's uranium reserves will be depleted around the turn of the century. Thereafter, continued and expanded use of nuclear power must rely upon successful development of the breeder reactor or, in the event of failure, of alternative processes based, for example, on the thorium-^{233}U cycle or fusion. Although several types of breeder reactors are under development, the most advanced, and the choice worldwide, is the liquid-metal-cooled fast breeder reactor (LMFBR).

Support of development of the LMFBR should be continued but thorough consideration should also be given to acquisition of technology from France or other countries that appear to be well ahead of the United States in the development of this technology.

Du Pont also recommends increased support of such other breeder types as the high temperature gas and molten salt reactors. In addition, funds should be provided for work on the thorium cycle as a backup in event of the possible failure of the breeder.

Long Term (Beyond 2000)

Du Pont agrees with ERDA's proposal to continue the former AEC work on fusion.

CONSERVATION

Many conservation measures have little or no technology content and are being incorporated into our everyday existence. Other measures based primarily on in-hand technology could be implemented well within the 1975-85 decade and could result in a significant

reduction of the nation's energy needs and consumption. There is need to improve these measures and others related to them through research, development, and demonstration programs. Five areas which merit attention are:

- more efficient combustion of fuel
- capture of energy values from waste
- increased energy efficiency in industry
- improved building design and retrofit for energy conservation
- more efficient conversion of electric energy to work

More Efficient Combustion of Fuel

The electric power industry is the largest single consumer of fuels by direct combustion. The industry uses about 20% of the nation's fossil fuels. Of this total, 58% is coal, 24% is natural gas, and 18% is oil. Efficiency of conversion of fuel to electric power averages about 35% for the entire industry. However, American Electric Power Company has reported that their newest generating stations have achieved 50% efficiency by using secondary recovery through topping turbines.

More effort should be made to control operating conditions to provide stoichiometric combustion. Available instrumentation could accomplish this saving by dynamically regulating air flow to accomplish complete combustion and minimum loss of heated air up the stack.

Attention to auxiliary uses of the waste low pressure steam from the turbine-generators is a near-term objective which can lead to appreciable energy saving. Some generating stations today operate at an over-all efficiency of 70% conversion because uses have been found for waste steam.

Recovery of Captured Energy Values from Waste

Government-supported programs on waste have focused primarily on pollution problems and have tended to overlook the opportunity for recovery of metals and other solid residues with high energy content. Much waste contains important components which would be more valuable if recovered and recycled than if burned. Simple incineration of bulk waste represents a loss of energy that might be captured through development of practical separation processes.

Increased Energy Efficiency in Industry

Industry uses about 37% of the nation's fuel, exclusive of the energy bought from electric power companies and energy used for transportation. One approach to energy savings is through increased efficiency of current operations. Another approach is to modify existing operations to reduce energy required. The latter should be expanded through support of R&D programs on alternatives to widely used energy-intensive industrial processes. Distillation is an example. Liquid-liquid extraction or membrane separation might contribute significant energy savings but the necessary R&D to establish feasibility is yet to be done.

Improved Building Design for Energy Conservation

Residential and commercial buildings use 36% of the nation's energy. Of this amount, 70% is accounted for by residential buildings where 36% of the energy is estimated to be wasted. If this waste were completely eliminated, 9% of the nation's energy requirements would be saved. A Ford Foundation analysis reports that one-half of this saving is practically realizable by 1985. Project Independence makes a similar prediction with greater qualification dependent upon Government actions.

None of the modifications required to achieve these energy savings are technically sophisticated and there do not appear to be any insurmountable technical barriers. There is, however, a need to provide incentives and motivations for consumers.

More Efficient Conversion of Electric Energy to Work

About 25% of the residential energy is used in electrical appliances. Recent studies at National Bureau of Standards (NBS) have shown that the electric efficiency of appliances ranges widely and depends importantly on engineering design. The NBS work has resulted in a program to use labels that indicate the energy efficiency of the manufactured product. This program and programs to improve design efficiencies should be encouraged and extended.

MSS
2/17/76

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February 23, 1976

The Honorable Henry M. Jackson
United States Senate
Washington, D. C. 20510

Dear Senator Jackson:

This is in response to your letter of January 30, 1976 requesting an assessment of the proposed ERDA budget for FY 1977. My comments will be limited primarily to the Fossil Energy Program.

ERDA's proposed program and budget for FY 1977 still does not reflect appropriate emphasis on near-term energy problems. The need for concentrating on the 1985 period is clearly pointed out in An Analysis of the ERDA Plan and Program, the Office of Technology Assessment report of October 1975. Since the review of ERDA-48 last summer by the OTA, the energy outlook for the near-term has continued to worsen, making it absolutely essential that ERDA's attention shift to fossil energy programs that will add significantly to domestic energy supply as soon as possible. ERDA's proposed Synthetic Fuels Commercialization Demonstration Program is a step in the right direction but the program is too limited in scope and, of course, does not yet have congressional authorization.

In support of my contention that our near-term energy outlook continues to worsen, consider the following:

Nuclear Energy - concerns over nuclear safety, citizen initiated referenda to ban nuclear power plants in 29 states, and continued cost problems plague the nuclear power program making it most unlikely that 1985 goals will be met.

Oil - In the year following the embargo our domestic oil production continued its downward trend dropping 443,000 B/D. During 1975 we lost another 400,000 B/D. The Independent Petroleum Association of America predicted that 1976 will see another drop of 224,000 B/D (Oil & Gas Journal, November 3, 1975, page 26). However, with the roll-back of oil prices mandated by Congress the decline in production will be larger. The IPAA also predicted that U.S. oil demand would increase by 677,000 B/D during 1976 if the economy continues its recovery from recession.

Also note that Canada, our largest non-OPEC oil supplier (1,000,000 B/D in 1973), has notified us that they will phase out exports to the United States by 1980. (The Rocky Mountain News of November 6, 1975 reported a decision of the Dominion government to slash exports to the U. S. in 1976 to a level of 500,000 B/D).

Gas - For natural gas, which provides 48% of the energy used by industry, marketed production declined by 6.8% or 4 billion cubic feet per day during 1975 (Oil & Gas Journal, January 26, 1976, page 108). Add to this the negative impact of the House-passed natural gas bill, which if sustained, will accelerate still further an almost unsolvable problem of gas supply. Already drilling rig utilization is dropping sharply in traditionally gas-prone petroleum provinces.

Coal - The coal picture is no brighter. Although U.S. production finally attained the 600 million ton level for the first time in 1975, the goal of doubling output by 1985 is only a distant and probably an unattainable dream. Expansion is hampered by continued restrictions on Federal coal leasing, Sierra Club vs. Morton, proposed Clean Air Act amendments, stagnation in improving transportation facilities and a cumbersome and unresponsive bureauracy.

Synthetic Fuels - During the year following the embargo industry committed $500 million in lease bonuses for four Federal oil shale tracts. At least 25 commercial synthetic fuels projects, including 7 oil shale and 15 coal gasification plants, were in some stage of development. Following negative action by the House of Representatives on synthetic fuels legislation that would have provided a mechanism for government to share the extraordinary risk of these pioneer plants (mostly political risk) almost all of these projects are being phased-down or moth-balled. Hundreds of technologists with synfuels experience assembled for these projects are being reassigned.

Most of the scientific manpower of the Federal government with energy expertise have been centralized in ERDA. Furthermore with its enormous budget and through its contractual relationships with industry, and the university community, ERDA controls a significant percentage of the energy-related scientific and technological capabilities of the nation. ERDA must avoid any misallocation of these resources since our trained and experienced manpower is not unlimited. ERDA must carefully consider the division of effort between the longer term and the more urgent shorter term needs of the nation.

ERDA's emphasis on coal liquefaction, demonstration plants and in situ technology in its Fossil Energy Development Program are examples of questionable allocation of resources. Its gasification programs also are suspect.

Coal Liquefaction

ERDA's coal liquefaction programs, including expenditures on demonstration plants, are the largest items in the fossil energy budget. Yet it is doubtful that any of the technology will be ready for commercial application prior to the 1990's. Perhaps even more important, cost estimates made by ERDA for the Synthetic Fuels Task Group, indicate that syncrude from coal will cost almost twice that from oil shale, yet insignificant funds are proposed to assist oil shale development.

Demonstration Plants

ERDA's demonstration plant program is a questionable concept. To attempt to scale-up and demonstrate second-generation technology without first having had experience with first-generation technology is sure to lead to failures, delays and costs that might be avoidable. Building a grassroots plant with complete up-stream and down-stream facilities merely to demonstrate one or two new steps in a processing sequence is time-consuming and costly to say the least. To invest hundreds of $ millions in non-commercial sized plants makes no sense at all.

What makes more sense to me is to build as quickly as possible an array of commercial synthetic fuels plants using proven technology. Then as second-generation processes are developed that show merit, test those steps needing scale-up experience in the already existing commercial plants. Trained and experienced people would be available as would up-stream and down-stream facilities and infrastructure. In the meantime the manpower and money that would go into the demo projects could be applied to pioneer commercial plants that would add to our oil and gas supply.

Oil Shale

The only ERDA oil shale programs noted in the budget for Fy 1977 are included under IN-SITU TECHNOLOGY. In-situ shale oil production, despite its hoped-for advantages over the mining approach, is by no means assured of success. Several major problems relating to environmental hazards, resource recovery and economics must be answered. At the same time mining and aboveground processing, though much farther advanced also have unanswered questions in the same categories.

We can afford no further delays in determining the role oil shale is to play in our near and mid-term energy supply. In the absence of an assured commercialization program that would include oil shale, both in-situ and conventional shale oil production methods must have added emphasis, preferably through cost shared projects with industry. Funding in the range of $1 billion over the next five years probably will be needed.

Coal Gasification

The research, development and demonstration programs on both high and low BTU gasification need to be more realistically related to the entire economic problem of obtaining gas from coal. The conversion of coal to gas is only one step in the process. Acquiring and develping the coal and water resource to support a coal gasification project, mining, transporting and handling the coal, processing the raw gas and pipelining the gas to market all have significant costs. In addition, providing solutions to environmental and socio-economic problems are no small part of the cost of gas from coal and are relatively independent of the process chosen to convert coal to gas.

In considering the allocation of scarce resources it seems wiser to me to concentrate on first-generation commercial applications of coal gasification technology rather than a proliferation of R,D&D projects whose ultimate economic contribution may be small at best, since the gasification step may represent no more than 25% of the total cost of gas from coal.

Synthetic Fuels Commercialization

Finally, I would like to comment on the synthetic fuels commercialization program. It is absolsutely essential that government take a risk-sharing role in establishing this vital industry. There are too many constraints on private capital to expect that industry will be able to do the job alone, in time.

In the President's 1975 State of the Union Message he targeted a goal of 1,000,000 B/D of synfuels production by 1985 (including the oil equivalent of synthetic gas). The Federal Task Force that studied and reported on the proposed program came to the conclusion that a 350,000 B/D "information program" was more appropriate and recommended an array of incentives to attain the scaled-down goal.

In my opinion the focus of the government's effort should avoid limiting numerical goals. Instead it should aim to remove administrative and economic roadblocks for those who have been trying to get started and seek to get all qualified entrants under way. Some are ready to proceed now with pioneer commercial plants based on years of prior work. Others are on a slower track or are now beginning. All qualified entities should be encouraged to proceed at the fastest pace each considers prudent.

If we are to require 5 to 10 million barrels-per-day of synfuels by the turn of the century, as suggested by Dr Robert Fri in his testimony to the House Committee on Science and Technology, there is no time to

lose. We have no possibility of developing a new set of technologies before proceeding to build such an industry. We must start with what we now know and apply the ingenuity and skills of a broad spectrum of industry to improve the technology as we go.

This should be the basic aim of ERDA's synthetic fuels commercialization program.

I appreciate your invitation to comment on ERDA's program and budget. If I can be of further assistance feel free to call on me.

Very truly yours,

Russell J. Cameron

RJC/saj

INSTITUTE FOR ENERGY ANALYSIS
P. O. Box 117 / Oak Ridge, Tennessee 37830 / (615) 483-8411

Office of the Director

February 10, 1976

The Honorable Henry M. Jackson
Chairman
Committee on Interior and Insular Affairs
United States Senate
Washington, D. C. 20510

Dear Senator Jackson:

Although I have responded to your request for suggested allocations in the ERDA budget, I believe that I can be more helpful to your committee by bringing out a number of essential points that our OTA Nuclear Panel covered in its deliberations:

1. Overall ERDA Budget

The overall energy R&D budget for ERDA for 1977 is $2,413 billion. This overall budget reflects historical trends in our budgeting for energy research, notably the $2 billion per year for 10 years proposed by you some three years ago. I believe, as did the OTA panel, that in view of the urgency of the energy crisis, we should reexamine our underlying perception of what constitutes an appropriate budget for energy R&D. I believe an overall budget twice as large as the present one is by no means out of the question, especially since, even at $5 billion, the Federal expenditure for energy R&D would be less than the maximum spent on space at the height of the Apollo Project.

2. Molten Salt Project

The OTA Nuclear Panel urged that the molten salt reactor be funded at such a level as to allow a determination of its true promise. Instead, this project has been cancelled. This, I believe, is a very serious mistake.

3. Siting

There is little in the ERDA program that aims at establishing a policy for the siting of breeders. As the enclosed letter to Paul Dragoumis of the Federal Energy Administration suggests, I believe this is a crucial long-term issue.

4. CO_2 Problem

Evidence is beginning to accumulate to suggest that CO_2 from burning of fossil fuel may pose a much more serious hazard than had been assumed. I would urge increase in the environmental budget of ERDA so that this matter can be looked into properly.

Sincerely,

Alvin M. Weinberg

AMW:bc
Enclosures

OPINION SURVEY

Alvin M. Weinberg

(1) Based on your participation in the Office of Technology Assessment's analysis of the ERDA long range plan, how would you allocate $1,000 to the various major programs in 1977?

PROGRAM	AMOUNT
Conservation	$ 53
Fossil Energy	195
Solar Energy	70
Geothermal Energy	44
Fusion Power Development	88
Fission Reactor Development	352
Nuclear Fuel Cycle	154
Environmental Control Technology	44
	$1,000

NUCLEAR SUB-PROGRAMS

Fusion: No change in relative allocation

Fission: Power Reactor Development

Base	$ 460
CRBR	237
Safety	82
Advanced Fuels	23
LWBR	51
GCR	43
MSBR	43
LWR	17
Support	31
Capital Equipment	13

Nuclear Fuel Cycle and Safeguards: No change in relative allocation

2-10-76

December 10, 1975

Dr. Paul Dragoumis
Office of Nuclear Affairs
Federal Energy Administration
12th and Pennsylvania Avenues
Room 1109
Washington, D. C. 20461

Dear Dr. Dragoumis:

I am writing to call to your attention what I consider to be one of the most important long-term policy questions affecting the nuclear option — the siting of breeder reactors. Briefly put, we must decide whether the basic policy for siting breeder reactors shall be a continuation of present reactor siting policy; or whether all breeders ought to be confined to nuclear parks.

As you probably know, when John Sawhill was Administrator of FEA he delivered a speech in which he all but suggested that all reactors deployed after 1990 be confined to nuclear parks. Since at the time it was a fair presumption that reactors after 1990 would be breeders, Sawhill's suggestion was tantamount to confining breeders to central sites. With reactors being delayed, it is not so clear any more that after 1990 all reactors will be breeders. Nevertheless, I believe it is extremely important to reach some breeder siting policy fairly soon so that the decision will not be pre-empted by inertia.

A decision to confine all breeders to nuclear parks is not one that can or should be made lightly: however the decision goes, it will have extremely far-reaching consequences, especially if nuclear breeders turn out to be the main long-term source of central electricity. I should therefore expect the matter ought to be the subject of a major study, of the same sort as NRC conducted for LWR's. The actual formulation of such a far-reaching policy seems to me to fall in the province of FEA, or even the Energy Resources Council, rather than NRC; I would think the study should be sponsored by FEA, or possibly jointly by FEA, NRC, and ERDA.

I would like very much to discuss this and related matters with you at your convenience. Could your office let me know when we could get together with you? Another possibility would be to invite you to visit us in Oak Ridge. We could then talk in a more leisurely fashion than would be possible in Washington and you could, on the same day you are at our Institute, talk to people at Oak Ridge National Laboratory.

Sincerely,

ORIGINAL SIGNED BY
ALVIN M. WEINBERG

Alvin M. Weinberg

AMW:bc

bc: Chester L. Cooper, IEA-ORAU, Washington, D. C.
Calvin C. Burwell, Oak Ridge National Laboratory
Ernest G. Silver, IEA

RESPONSE OF MR. ERIC H. REICHL, PRESIDENT
CONOCO COAL DEVELOPMENT COMPANY, STANFORD, CONNECTICUT

OPINION SURVEY

(1) Based on your participation in the Office of Technology Assesment's analysis of the ERDA long range plan, how would you allocate $1,000 to the various major programs in 1977?

PROGRAM	REICHL AMOUNT	ERDA
Conservation	50	45
Fossil Energy	250	220
Solar Energy	30	58
Geothermal Energy	20	25
Fusion Power Development	100	151
Fission Reactor Development	300	353
Nuclear Fuel Cycle	200	140
Environmental Control Technology	50*	8
* Stack gas cleanup	1000	1000

see over

(2) How would you allocate $1,000 to the sub-programs in one or more of the program areas with which you are familiar? For example, the sub-programs in the Conservation Program are listed on page 4 of the statistical highlight booklet as follows:

SUB-PROGRAMS	AMOUNT
Electric Energy Systems	
Energy Storage Systems	
Industry Conservation	
Buildings Conservation	
Transportation energy conservation	
Improved Conversion efficiency	

(3) Please provide any comments or suggestions you might have regarding the proposed 1977 budget. Of special interest are opinions reached by your panel regarding the long range plans, that are not reflected in next year's budget.

1. The U.S. R & D budget is ~~woefully~~ short ~~on efforts to~~ resolve the crucial nearterm, stackgas clean-up problem. It should be pursued (by EPA and ERDA) by simultaneous testing (at 100 MW scale) of 3-4 second ~~generation processes. No other clean-up concept offers the same advantages~~ in cost and timing for large, baseload, coalburning power plants.

2. The '77 capital budget (P. 19, Major Construction Budget, Statistical Highlights) is $47.3 million for 3 Demonstration plants to cover COALCON, 1 Hi BTU, 1 lo BTU project. I believe this amount is inadequate if these projects (particularly the gas job) are to be pursued at least through Phase I on a multiple basis. This must be done to assure proper process selection.

In general, the liquefaction program has been: too large (plant size), too narrow (not enough alternates), too soon (not ready for Demo). The gasification program: Too "far out."

February 6, 1976

Solar Energy Applications Laboratory

Colorado State University
Fort Collins, Colorado
80523

Senator Henry M. Jackson, Chairman
Committee on Interior and Insular Affairs
United States Senate
Washington, D.C. 20510

1976

Dear Senator Jackson:

I am pleased to answer your invitation of 30 January, to comment on the ERDA 1977 budget. I hope my recommendations and comments will be useful to your committee.

Sincerely yours,

George O.G. Löf

George O.G. Löf

GOGL:kmck
Enclosure

OPINION SURVEY

(1) Based on your participation in the Office of Technology Assesment's analysis of the ERDA long range plan, how would you allocate $1,000 to the various major programs in 1977?

PROGRAM	AMOUNT
Conservation	90
Fossil Energy	200
Solar Energy	90
Geothermal Energy	40
Fusion Power Development	150
Fission Reactor Development	300
Nuclear Fuel Cycle	100
Environmental Control Technology	30
	1000

(2) How would you allocate $1,000 to the sub-programs in one or more of the program areas with which you are familiar? For example, the sub-programs in the Conservation Program are listed on page 4 of the statistical highlight booklet as follows:

SUB-PROGRAMS	AMOUNT	
Electric Energy Systems		I agree with the proposed budget in Conservation Research and Development
Energy Storage Systems		
Industry Conservation		
Buildings Conservation		
Transportation energy conservation		
Improved Conversion efficiency		

(3) Please provide any comments or suggestions you might have regarding the proposed 1977 budget. Of special interest are opinions reached by your panel regarding the long range plans, that are not reflected in next year's budget.

Solar Energy Development Sub-Program

Heating and Cooling	500
Agricultural & Process Heat	50
Solar Electric Applications	350
Technology Support & Utilization	50
Fuel from Biomass	50
	1000

Comments: In major programs, fission, fusion, and nuclear fuel cycle are grossly overfunded, and all other energies are underfunded. My recommendations are based on this view.

In solar programs, low temperature heat for buildings and industry is far more important and has much greater potential than electric power production for several decades. The proposed funding is seriously unbalanced and fails to recognize these facts. The above recommendations will provide ample research funds for electric power investigations and will accelerate the near-term application of economical solar heating and cooling.

OPINION SURVEY

(1) Based on your participation in the Office of Technology Assesment's analysis of the ERDA long range plan, how would you allocate $1,000 to the various major programs in 1977?

PROGRAM	AMOUNT
Conservation	$50
Fossil Energy	200
Solar Energy	100
Geothermal Energy	25
Fusion Power Development	100
Fission Reactor Development	350
Nuclear Fuel Cycle	150
Environmental Control Technology	25

(2) How would you allocate $1,000 to the sub-programs in one or more of the program areas with which you are familiar? For example, the sub-programs in the Conservation Program are listed on page 4 of the statistical highlight booklet as follows:

SUB-PROGRAMS	AMOUNT (SOLAR)	
Electric Energy Systems	DIRECT THERMAL:	$300
Energy Storage Systems	AGRICULTURAL:	25
Industry Conservation	SOLAR ELECTRIC:	600
Buildings Conservation	TECHNICAL SUPPORT	50
Transportation energy conservation	BIOMASS	25
Improved Conversion efficiency		

(3) Please provide any comments or suggestions you might have regarding the proposed 1977 budget. Of special interest are opinions reached by your panel regarding the long range plans, that are not reflected in next year's budget.

IT IS DISAPPOINTING THAT THERE ISN'T EVEN THE SMALLEST ALLOWANCE FOR RESEARCH ON SPACE-BASED SOLAR POWER SYSTEMS IN FY 77, DESPITE THE FACT THAT THEIR TECHNICAL & ECONOMIC RISKS ARE FAR LOWER THAN THE HEAVILY-FUNDED NUCLEAR FUSION POWER SYSTEMS.

J Grey 2/17/76

SEIA

Reply To: Olin Brass
Olin Corporation
East Alton, Illinois 62024

February 10, 1976

Honorable Henry M. Jackson
United States Senate
Committee on Interior and Insular Affairs
Russell Senate Office Building - Room 137
Washington, D.C. 20510

Dear Senator Jackson:

This will reply to your letter of January 30 requesting comments on the Energy Research and Development Administration's FY-1977 Budget.

As a representative of the Solar Energy Industries Association, I have been called on by Congressman McCormack's House Subcommittee to testify February 19 on the same subject. Unfortunately, the full text of my written testimony has not yet been completed. Copies will be sent you when they are ready.

With respect to the questionnaire attached to your letter, we do not feel particularly competent to comment upon portions of the E.R.D.A. budget relating to areas other than solar. The table attached contains our detailed recommendations for changes in the E.R.D.A. solar budget.

The explanation of these recommendations is incorporated in the attached paper which is a portion of the testimony to be presented February 19.

Very truly yours,

S. H. BUTT, President
Solar Energy Industries Association

/crc
enc.

cc/Mr. John H. Blake III
Solar Energy Industries Association
1001 Connecticut Avenue, N.W.
Washington, D.C. 20036

SOLAR PROGRAM COMMENTS AND RECOMMENDATIONS - DIRECT THERMAL APPLICATIONS

Heating and Cooling of Buildings

The basic philosophy of E.R.D.A.'s program is that improved solar systems and components must first be developed. Following this, their technical and economic performance must be demonstrated and evaluated. Then, and only then, will broad efforts to commercialize them be undertaken. This is a "sequential concept." The Federal Energy Administration has proposed a quite different concept in which commercialization and continuing development are carried out concurrently. This "concurrent concept" is the concept favored by the Solar Energy Industries Association.

Solar hardware does exist today, it is available in the marketplace, it is being marketed and installed today. This hardware is serviceable and cost-effective. This has occurred within the past year. This fact makes it possible to adopt the concurrent concept.

A program structured to support concurrent commercialization and continuing product development offers many advantages. Among these are:

1. Government efforts to assist commercial market development through the E.R.D.A. program, as well as through proposed user incentives and the proposed Government buildings program, will lead industry to accelerate their own privately funded research and development activities aimed at developing new products and improving existing products. In the long run, acceleration of industry funded research and development will reduce the cumulative cost of the research and development programs to be funded by the Government and ultimately largely replace Government funded research and development.

2. Accelerated market development will accelerate the development of the industry infrastructure required to support a large-scale commercial industry. The rate at which this infrastructure can be developed is one of the key constraints which limite the rate at which solar direct thermal applications can enter service and therefore, the rate at which they can make an effective contribution to the energy problem.

We have examined E.R.D.A.'s direct solar thermal programs from the point of view of two questions: What must be done to change them so that they are supportive of concurrent market and product development? What must be done to better adapt E.R.D.A.'s research and development programs to the realities of industry and market requirements? (E.R.D.A. and other agencies may now not correctly perceive industry and market requirements.)

Let us begin with the demonstration program mandated by Public Law 93-409.

In the context of the "sequential concept," the primary objective of the demonstration program would be defined as achieving technical success only. Effectively, this means proving that the systems will function technically and may be projected to be cost-effective in a variety of operating conditions represented by a number of climatic areas.

The "concurrent concept" demands that market development be the major thrust. Market development objectives require that the demonstration program encourage potential users--individual homeowners, builders, developers, owners of apartment buildings, builders and owners of commercial and industrial buildings, architects and engineers--to accept solar installations as a technically and economically viable energy source and to individually decide to utilize this source.

One very obvious difference between these two concepts of the purpose of demonstration is the number and location of the demonstration installations. To illustrate this point, we may note that climatically, Kansas City, St. Louis, Indianapolis, Louisville and Cincinnati are very similar. If the purpose of the program is only to demonstrate that a solar heating system is technically viable in any of these areas, we agree that demonstration in only one is required. To obtain operating data to be used in general economic analysis, demonstration in only one of the metropolitan areas is also needed. To the extent that moderate climatic differences exist between the five areas, results from one can be adjusted to suit each of the others using available climatic data. However, if the purpose is market development, there must be adequate demonstration in all five areas. The bulk of the "public" which a market development oriented demonstration program must reach in each area will simply not travel long distances to inspect a demonstration installation. The question of whether or not the demonstration program is intended to have market development as one major objective is at the root of the continuing controversy concerning the number of demonstrations which are needed.

Another equally important difference between the two concepts is that, in the case of the sequential concept, "demonstrations" may be looked upon as the final step in development. In many cases, E.R.D.A. and N.A.S.A. now propose that the systems demonstrated will be the prototypes delivered at the conclusion of a development program. This implies that demonstration installations are to be regarded as a "test bed."

We do not disagree that field test of systems and components developed as a result of Government funded product development programs is desirable and necessary. It is normal practice in the private sector for manufacturers planning to market a new product to field test it first. We are not in any way opposed to field testing as a part of "Development in Support of Demonstration." However, "field test" is <u>not</u> a proper part of public demonstration. Market development oriented demonstration requires that the systems demonstrated be those which have already been

found to be technically and economically viable either as a result of Government field testing, as a result of field testing in the private sector or, perhaps best, as a result of successful commercial installation in the private sector.

The basic reason for this difference is that public market development demonstration must avoid either technical or economic failure. The E.R.D.A.-N.A.S.A. program tends to confuse the difference between "Field Test" and "Public Demonstration." The reason for this confusion seems to be that the market development function of the demonstration program itself is not too well recognized. Unfortunately, failure to recognize the market development function and failure to recognize what is required for market development in a diffuse market is most evident in N.A.S.A. activities.

We have recommended previously that definitive market research studies be undertaken to define the number of demonstrations required during the time span of Public Law 93-409 to achieve adequate market development results. I have not seen the results of any such studies and indeed, do not at this moment know whether or not such studies have even been started. As a first approximation, I suggest that there are approximately fifty market areas in which market development demonstration should be conducted. (In some cases, because of the geographical size of some of the larger metropolitan areas, there is more than one market area within a metropolitan area.) I believe that, in order to demonstrate adequately in each, no less than sixty residential installations are required over the five year period in each of the fifty market areas. In the aggregate, this means 3,000 installations over five years. My reasons follow:

1. There is a requirement to successively demonstrate "improved models" year by year as industry and/or Government development programs produce results.

2. There is considerable diversity in the residential structures upon which solar installations are to be demonstrated. Three single-family residences of different characteristics and one multiple family dwelling should be included in a "normal" year's program for each general type of system to be demonstrated.

3. There are a number of generically different types of systems including: liquid heat transfer systems, air systems, heat pump assisted systems, etc.

4. Finally, in some measure, application to retrofit as well as to new structures must be demonstrated.

A Five Year Program with four building types and four generic types of systems for each building type and demonstration in both new construction and retrofit would total 160 units in each market area over the life of the program (5 x 4 x 4 x 2). However, suitable systems for

all applications will not be available during the earlier years and in some cases, a single demonstration may serve more than one purpose. Recognizing these factors, I have somewhat arbitrarily cut the total per market area to sixty.

Residential Demonstrations:

Fiscal Year 1977 is the second year of the demonstration program. Fiscal Year 1976 is scheduled to provide only 110 residential demonstrations, leaving 2,890 for the final four years. Fiscal Year 1977 can be looked at as still being a "build up" year and installation of one-fourth of the remaining 2,890 units would be excessive in Fiscal Year 1977. We recommend that the objective for Fiscal Year 1977 be increased from 200 demonstrations, as now called for in the E.R.D.A. Budget, to 500. Based upon E.R.D.A.'s statement that an additional $2,300,000 in FY-1977 is required to finance an additional 90 demonstrations over those provided for in FY-1976, the increase in funding works out at $7,800,000. This is probably an "outside" figure. For one thing, the present E.R.D.A. budget provides that half of the 200 demonstration installations to be made in FY-1977 be fully instrumented. It is our general understanding that instrumentation costs are greater than the balance of the installation cost. We would question the necessity of instrumenting 250 out of 500. Additionally, some economy of scale should derive from increased program size. Recognizing these factors, we propose that the demonstration program budget for residential demonstrations be increased by $5,000,000 and that E.R.D.A. be asked to commit to make a total of 500 demonstrations with a total budget of $11,300,000.

Commercial Demonstrations:

The budget for commercial demonstrations requested in FY-1977 is very nearly the same (actually, slightly lower) than the FY-1976 budget. The E.R.D.A. proposal explains that the level of "demonstration" planned in 1977 "is the minimum level to ensure the technical achievement of the program objectives within the schedule constraints required by the Solar Heating and Cooling Demonstration Act." This statement recognizes technical objectives only. We propose that market development demonstrations be added. We propose a total of fifty "market development" commercial demonstrations distributed among 25 metropolitan areas. On the basis of E.R.D.A.'s current proposal, it appears that a total of 68 commercial demonstrations are covered by FY-1976, the transition quarter, and FY-1977. This implies an average cost of $400,000. We propose that the additional market development demonstrations in the commercial area be of a "cost-sharing" nature in which the owner of the structure will be expected to provide 50% of the cost of the installation exclusive of instrumentation. Upon this basis and recognizing that the market development installations will be somewhat more standardized than the generally "one of a kind" technical demonstrations provided for in the present program, we believe that E.R.D.A. should commit to 50 commercial market development demonstrations (in addition to their basic program) in FY-1977 at a total additional cost to the Government of $7,500,000.

Water Heater Market Development:

For a variety of reasons, solar water heaters today are "most ready" for market development. We propose a concentrated two year market development oriented solar water heater demonstration program beginning in FY-1977. We recommend an average of 100 single family water heater market development demonstration installations in each of fifty market areas and an average of ten multi-family water heater demonstrations in each of 25 metropolitan areas. We recommend further that these market development demonstration installations be on a cost-sharing basis with at least 25% of the cost being borne by others than the Federal Government. We recommend that at least 50% of these installations be coordinated with utilities, both electric and gas, and that at least in these cases, the control systems provided with the water heaters be such that the water heater's energy storage capability is used to best advantage to provide utility load management functions. We estimate that, upon this basis, the objectives would require a Federal expenditure of $6,875,000 in FY-1977.

The total of the increases recommended in the demonstration program is $19,375,000.

Research and Development:

Funding for research and development is requested in FY-1977 at a level of $8,200,000. The explanation provided by E.R.D.A. indicates to us that this funding is adequate and program concepts sound.

Development in Support of Demonstration:

Funding requested by E.R.D.A. for Development in Support of Demonstration in FY-1977 is $7,800,000. The explanation provided by E.R.D.A. indicates to us that this funding is adequate.

AGRICULTURAL AND PROCESS HEAT

E.R.D.A. requests $2,500,000 in FY-1977 for agricultural and industrial process heat applications. We recognize that, in general, efforts in this area are truly still in the developmental stage and the program recommended by E.R.D.A. appears appropriate.

Thus, our recommendations for the Direct Thermal Application Program in the aggregate increase the FY-1977 budget from the requested level of $37,000,000 to $56,375,000.

TECHNOLOGY SUPPORT AND UTILIZATION

We accept E.R.D.A.'s estimates of $1,300,000 for solar energy resource assessment and of $1,000,000 for the Solar Energy Research Institute.

We have recommended reorientation of Direct Thermal Application Programs to add substantial market development activity. Coincident with this, there is need for a substantial increase in activity and funding in the area of "Technology Utilization and Information Dissemination." It is our judgment that the $700,000 requested is totally inadequate when the market development mission is recognized. We recommend that general funding be increased to $2,000,000 from the $700,000 presently requested. We recommend that much of the increase be directed towards instructional programs at the local level.

As a further support to training and familiarization efforts, we recommend that at least fifty demonstration-instructional solar installations be made in universities and community colleges. The training of architects, engineers and technicians in "solar technology" is a necessary part of development of an industry infrastructure. Installations should be generally of residential demonstration size but should be fully instrumented and specially designed to accommodate modification as the state of the art advances. Cost-sharing with the university or college should be sought wherever feasible. Upon this basis, we project an average cost of $40,000 for each of the fifty installations or a total cost of $2,000,000.

SOLAR ELECTRIC APPLICATIONS

Solar Thermal Electric Conversion

The budget request for solar thermal electric conversion has been increased by 150% to $26,500,000.

We question the wisdom of the increase from $750,000 to $4,750,000 in funds requested for development of "advanced distributed collector concepts." Earlier in E.R.D.A.'s narrative, the statement is made, "Studies in FY-1975 identified the central receiver concept as having a greater potential for economic viability as compared to distributor collector concepts." Certainly, this is a conclusion with which we must agree, particularly so when one considers the difficulties inherent in moving collected heat economically and without excessive loss from a large area of distributed collectors to a central point. This difficulty is a fundamental shortcoming of the distributed collector concept as compared to the central receiver concept. We must also note that the efficiency of the water-steam cycle employed to convert thermal energy into electric energy depends upon initial steam temperatures and pressures being quite high. As a generality, the same comment applies to other liquid-vapor systems. The difficulty and cost of collecting heat from a dispersed source, such as a large field of distributed collectors, must logically increase greatly with increases in temperature and pressure employed. Therefore, it is recommended that the budget request for distributed collector studies be held at the level of $750,000, a reduction of $4,000,000.

Desalination:

We suggest that preliminary studies be undertaken in conjunction with the solar thermal electric program of the concept of the use of large-scale solar energy collection to drive large-scale desalination apparatus. In years past, considerable progress was made upon the development of efficient and relatively cost-effective large-scale desalination apparatus by the Office of Saline Water of the Department of the Interior. (Much excellent work in this area was performed at E.R.D.A.'s Oak Ridge Laboratory.)

At least superficially, the application seems to be well suited to solar use. Temperatures required to drive desalination equipment are quite moderate. Heat necessary to maintain operations overnight can be stored as unpressurized heated water if some modest sacrifice of desalting plant efficiency can be accepted and even if no compromise is made with efficiency, the maximum temperature requirement for the heated brine in desalination equipment is only 250°F, implying only modest pressurization of overnight storage. There is no compelling need for continuous operation during prolonged cloudy periods. With moderate energy storage, it is believed that a solar powered desalination plant could be operated quite efficiently without the use of auxiliary energy resources.

In general, the potential requirement for desalted water is in low rainfall areas in which cloud cover is an infrequent problem and in which ambient temperatures are generally relatively high, both factors which would tend to improve efficiency of the solar heat source for a desalination plant.

We understand that one of the institutional impediments to accelerated exploitation of western coal resources and to exploitation of shale oil resources is the problem of water availability throughout the Mountain States. A conflict which exists between the existing claimants for the available water for use in irrigation and "new" claims developing as a result of proposed shale oil and western coal exploitation. In addition, we recognize that, in the Mountain States and in the Southwest, there is considerable potentially productive land available which would become productive if water were available. At present, much water originating in the Mountain States or elsewhere in the Southwest, principally that flowing into the Colorado River and its tributaries, is "exported" to Southern California. Presumably, this water could be diverted to use nearer to its origin so as to resolve some of the problems of water availability in the Mountain States and in the nearer Southwest if its use in coastal regions could be replaced by desalted water.

A conceptual study is recommended. It would initially involve evaluation of the previously developed desalination technology in conjunction with the large-scale thermal collection technology now being developed in this portion of the solar program. The cost of an initial conceptual study should be modest, $500,000 in FY-1977.

PHOTOVOLTAIC ENERGY CONVERSION

We are in agreement with the program proposals and funding proposed in the area of photovoltaic energy conversion.

WIND ENERGY CONVERSION

We are in agreement with the programs and funding proposed for wind energy to electricity conversion systems.

We suggest that studies to define and prepare initial conceptual studies of the extended use of wind energy in nonelectric generation applications be initiated. An example might be the provision of pumping power to primary irrigation aqueduct systems. Hypothetically, in such an application, the interruptible nature of the wind energy would not necessarily present a severe problem since energy could be "stored" to assure continuous flow in the aqueduct by pumping into elevated reservoirs. A budget provision of $1,000,000 is recommended for this purpose.

OCEAN THERMAL ENERGY CONVERSION

We have problems in accepting E.R.D.A.'s proposals for programs and funding in this area. The thermal gradients available even in the most advantageous ocean areas are quite modest.

The low temperature differentials available in ocean thermal gradients dictate that conversion of heat to electric energy in this manner is, at best, relatively inefficient. Low basic efficiency means that large amounts of heat must be transferred per unit of electrical energy generated. The further requirement that temperature differentials across heat exchangers must be minimized dictates that heat exchange surface area per unit of heat transferred must be relatively large.

The existing technology for heat transfer to and from seawater has been developed over an extended period of years and such heat exchangers have been in large volume use for many years.

It is our belief that, unless the cost-effectiveness of the present state of the art seawater heat exchange technology can be very greatly improved without sacrifice of reliability, there is little hope that a closed Rankine cycle ocean thermal energy conversion plant can be cost-effective.

It is evident that much of the ocean thermal work programmed during FY-1977 can have calidity only if the heat exchanger cost-effectiveness questions can be resolved. The history of seawater heat exchanger technology suggests that risks are high and chances of success modest.

It is recommended that general continuing work in ocean thermal energy conversion be held at a quite low level and/or delayed pending resolution of the heat exchanger issue. An exception to this is the exploratory development of promising power cycle options which may be substantially more efficient in the conversion of heat energy at low thermal gradients into electric power than a closed Rankine cycle system.

It is suggested that a total budget for ocean thermal energy conversion of $3,500,000 should be adequate or more than adequate to support heat exchanger research and development, exploratory development of promising power cycle options and long lead time corrosion testing activities.

SUMMARY OF RECOMMENDATIONS

Solar Energy Program Budget Recommendations, (Outlay Basis)
(Dollars in Thousands)

	FY-1976 Per ERDA	FY-1977 Per ERDA	FY-1977 Recommended
1. Heating & Cooling of Buildings	$24,800	$ 34,500	$ 34,500
Recommended Changes			
a. Additional Res. Demos.			+ 5,000
b. Additional Comm'l. Demos.			+ 7,500
c. Water Heater Program			+ 6,875
	$24,800	$ 34,500	$ 53,875
Agricultural & Process Heat	3,700	2,500	2,500
Sub-Total	$28,500	$ 37,000	$ 56,375
2. Technology Support & Utilizations			
a. Solar Energy Resource Assessment	$ 900	$ 1,300	$ 1,300
b. S.E.R.I.	1,600	1,000	1,000
c. Technology utilization and information dissemination, basic college and university teaching & demo. installations	600	700	2,000
d. Solar storage	1,500	0	0
Sub-Total	$ 4,600	$ 3,000	$ 6,300
3. Solar Electric Applications			
a. Solar Thermal Electric	$10,600	$ 26,500	$ 26,500
i. Reduce distributed collector effort			- 4,000
ii. Conceptual study, solar desalination			+ 500
	$10,600	$ 26,500	$ 23,000

	FY-1976 Per ERDA	FY-1977 Per ERDA	FY-1977 Recommended
b. Photovoltaic Energy Conversion	$16,000	$ 22,000	$ 22,000
c. Wind Energy Conversion	11,000	12,000	12,000
i. Studies of nonelectric applications			+ 1,000
	$11,000	$ 12,000	$ 13,000
d. Ocean Thermal Energy Conversion	$ 6,000	$ 7,000	$ 7,000
i. Reduce effort except in heat exchangers, long lead time testing and non-Rankine cycle development			- 3,500
	$ 6,000	$ 7,000	$ 3,500
Sub-Total, Solar Electric	$43,600	$ 67,500	$ 61,500
4. Fuels from Biomass	$ 3,830	$ 3,000	$ 3,000
TOTAL SOLAR ENERGY DEVELOPMENT	$80,530	$110,500	$127,175

NON-SOLAR PROGRAM AREAS

We do not feel that we are competent to recommend which programs in the non-solar area might be reduced to provide the $16,675,000 increase in the solar program called for above. Indeed, we are not in a position to determine whether or not funding for any other program should be reduced or the $16,675,000 increase in the solar program made as a net addition to E.R.D.A.'s total program.

Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

February 10, 1976

Hon. Henry M. Jackson
Chairman, Committee on Interior
and Insular Affairs
United States Senate
Washington, D.C. 20510

Dear Senator Jackson:

Thank you for the opportunity to comment on ERDA's FY '77 budget request.

As a participant in the Office of Technology Assessment evaluation, I had the opportunity to review, in detail, ERDA's long range energy research and development plan. Overall, I was impressed with its responsiveness to the nation's energy needs, and with the depth of understanding shown by ERDA's management in justifying the budget.

In reviewing ERDA's program, it is important to recognize that in our industry, the Electric Power Research Institute directs its principal efforts toward near term research and development needs, while ERDA is concerned with needs for the longer pull. Taken together, these two programs go a long way toward satisfying a large spectrum of the research and development requirements of the utility industry. Nevertheless, there is an urgent need to proceed with a number of large scale, albeit expensive, pilot plant demonstrations. This must be done at a more rapid pace than the private sector can justify. To this end, allocation of additional funds to such pilot plant facilities would help accelerate technology development to relieve shortages of oil and natural gas, and therefore would have lasting benefits for the nation's consumers.

For example, there are several technologies which are far enough advanced to warrant large scale pilot plant demonstration. These include technology for producing liquid fuels from coal, synthetic natural gas from coal, and low BTu gas for combined cycle electric power generation. It is important to recognize that such plants are experimental, and not competitive at today's prices for oil and natural gas. Therefore, it is unrealistic to expect the private sector to take sole responsibility for such demonstrations, for a number of reasons. One is that the financial risks far outweigh the prospects for offsetting economic benefit. Therefore, when national objectives call for acceleration in the development of these technologies, federal government assistance is justified. Such assistance may also be necessary to help establish new industries to supply and service these technologies on a competitive basis.

It seems to me that further funding of research and development on new oil and natural gas extraction technology promises early benefit for the consumer because it could relieve shortages of transportation fuels. Also, the OTA panel on which I served was very much impressed with the urgency for an early demonstration of the preferred technology for permanent high level radioactive waste disposal. This should go a long way toward relieving public concern over this problem. It is an essential step toward the objective of recycling nuclear fuel on a commercially viable basis.

Finally, I believe the level of funding in ERDA's FY '77 budget for solar energy and conservation is more than adequate. Near term developments in conservation have the potential for some reduction in the growth of oil and natural gas consumption. However, the greatest gains in this area will come from phasing out obsolete, inefficient facilities. The prospects for immediate major gains in solar power technology are not bright, despite recent increases in funding levels. Unfortunately, major breakthroughs in photo voltaic conversion and energy storage are needed before solar power can have a significant impact on the overall energy supply and demand balance. It is unlikely that these breakthroughs can be advanced significantly by spending more money on research and development at this time.

I hope my comments are responsive. Enclosed are the answers to specific questions you raised in the survey. Please let me know if you have any further questions.

Sincerely,

R. M. Lundberg
General Staff Engineer

OPINION SURVEY

(1) Based on your participation in the Office of Technology Assesment's analysis of the ERDA long range plan, how would you allocate $1,000 to the various major programs in 1977?

PROGRAM	AMOUNT
Conservation	$ 30
Fossil Energy	220
Solar Energy	50
Geothermal Energy	40
Fusion Power Development	160
Fission Reactor Development	340
Nuclear Fuel Cycle	150
Environmental Control Technology	10
TOTAL	$1,000

(2) How would you allocate $1,000 to the sub-programs in one or more of the program areas with which you are familiar? For example, the sub-programs in the Conservation Program are listed on page 4 of the statistical highlight booklet as follows:

SUB-PROGRAMS	AMOUNT
Electric Energy Systems	
Energy Storage Systems	
Industry Conservation	
Buildings Conservation	
Transportation energy conservation	
Improved Conversion efficiency	

(3) Please provide any comments or suggestions you might have regarding the proposed 1977 budget. Of special interest are opinions reached by your panel regarding the long range plans, that are not reflected in next year's budget.

FOSSIL ENERGY DEVELOPMENT

Coal Liquifaction	$150
Gasification	
High BTU	90
Low BTU	65
Advanced Power Systems	42
Direct Combustion	97
Advanced Research and Supporting Technology	69
Demonstration Plants	285
Magnetohydrodynamics	55
Other Capital Equipment	—
Petroleum and Natural Gas	
Gas and Oil Extraction	85
Supporting Research	5
Other Capital Equipment	—
In-Situ Technology	
Oil Shale	40
In-Situ Coal Gasification	15
Supporting Research	2
Other Capital Equipment	—
TOTAL	$1,000

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February 5, 1976

Honorable Henry M. Jackson, Chairman
Senate Committee on Interior and
Insular Affairs
United States Senate
Washington, D. C. 20510

Dear Senator Jackson:

Enclosed you will find my response to the Opinion Survey you sent to me.

With regard to item (1), I would view attainment of the following funding distribution by 1979 as a desirable ERDA objective: nuclear energy (including fission and fusion reactors and the nuclear fuel cycle), 40%; advanced fossil-fuel technologies and waste utilization, 25%; advanced non-fossil-fuel technologies (including energy production from plants, solar heating and cooling, photovoltaic power generation, OTEC, hydrothermal energy, dry geothermal energy, etc.), 20%; conservation, 10%; environmental control technology, 5%.

The members of the OTA Environment and Health Panel view the present ERDA commitment to environmental and health research as inadequate and have emphasized in particular the absence of a significant implementation program relating the development of new energy technologies to socio-political constraints. Multiple resource requirements associated with competition for scarce materials (e.g., water in the arid West) have received insufficient attention in the context of integrated regional development plans. Long-term constraints on the development of new energy technologies associated with climatic changes produced by heat addition and pollutant production require early identification since they may influence decisions concerning a reasonable balance between such complementary activities as the production of biomass and coal utilization.

I shall be happy to provide you with additional information.

Sincerely yours,

S. S. Penner
Professor of Engineering Physics & Director, Energy Center
Chairman, OTA Panel on Environment and Health

SSP/kh

p. s. Under separate cover, I am sending you copies of the first two volumes of our energy books, which may be useful to you in your work.

OPINION SURVEY

(1) Based on your participation in the Office of Technology Assessment's analysis of the ERDA long range plan, how would you allocate $1,000 to the various major programs in 1977?

PROGRAM		AMOUNT	
Conservation		50	
Fossil Energy	Conventional[1]	100 - Loans	
	Advanced[2]	100 - RD&D	
Solar Energy		100	
Geothermal Energy		50 - Loans 50 - RD&D	
Fusion Power Development		125	500
Fission Reactor Development		263	
Nuclear Fuel Cycle		112	
Environmental Control Technology		50	

[1] Coal gasification, coal mining, off-shore drilling, etc.
[2] In situ shale-oil recovery and coal gasification, MHD, secondary and tertiary oil recovery, gas stimulation, etc.

(2) How would you allocate $1,000 to the sub-programs in one or more of the program areas with which you are familiar? ~~For example, the sub-programs in the Conservation Program are listed on page 4 of the statistical highlight booklet as follows:~~

ENVIRONMENTAL RESEARCH	AMOUNT
Health Studies	350
Biological Studies	200
Environmental Studies	200
Physical and Technological Studies	150
Analysis and Assessment	50
Education and Training	50

(3) See attached letter.

III. Opinion Survey Letter

U.S. Senate,
Committee on Interior and Insular Affairs,
Washington, D.C., January 26, 1976.

Dear ———: Last summer, you participated in an evaluation of a long range plan proposed by the Energy Research and Development Administration. This experience has provided you with a unique vantage point from which to assess the proposed spending by ERDA in the coming fiscal year.

It would be helpful to us in considering ERDA's budget request to have your answers to the questions on the attached sheet. Your answers could be used to identify areas that require further invesigation on our part during budget hearings.

Enclosed are two booklets which present ERDA's 1977 budget in reasonable detail. Page 3 of the statistical highlights booklet shows a breakdown of direct energy program costs, while pages 4–14 show subprograms costs for each of the Programs and for associated supporting research. Our questions are concerned mainly with the appropriateness of resource allocation among these programs and subprograms.

We would appreciate your response as soon as possible, and at the latest by February 10, 1976. Thank you for your cooperation and assistance.

Sincerely yours,

Henry M. Jackson, *Chairman.*

Enclosures.

OPINION SURVEY

(1) Based on your participation in the Office of Technology Assessment's analysis of the ERDA long range plan, how would you allocate $1,000 to the various major programs in 1977?

Program:	*Amount*
Conservation	
Fossil Energy	
Solar Energy	
Geothermal Energy	
Fusion Power Development	
Fission Reactor	
Development	
Nuclear Fuel Cycle	
Environmental Control	
Technology	

(2) How would you allocate $1,000 to the subprograms in one or more of the program areas with which you are familiar? For example,

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the subprograms in the conservation program are listed on page 4 of the statistical highlight booklet as follows:

Subprograms:	*Amount*
Electric Energy	
Systems	
Energy Storage	
Systems	
Industry Conservation	
Buildings Conservation	
Transportation Energy	
Conservation	
Improved conversion	
Efficiency	

(3) Please provide any comments or suggestions you might have regarding the proposed 1977 budget. Of special interest are opinions reached by your panel regarding the long range plans, that are not reflected in next year's budget.

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